RESEARCH DEPARTMENT

THE SENNHEISER TYPE MD 82 AND ELECTROVOICE TYPE 642 MICROPHONES

Report No. L-052

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SUMMARY

The Sennheiser type MD 82 and Electrovoice type 642 are both directional microphones in which sound is received through openings along a narrow tube. Type MD 82, a number of which are in use in the Corporation, is no longer in regular production but is included in this report for comparison with the currently available type 642. Measured frequency characteristics and polar patterns are given.

1. INTRODUCTION

There are a number of applications in broadcasting for a microphone having a directivity pattern which is narrower than the conventional cardioid or figure-of-eight over at least part of its frequency range. In open-air broadcasts, for example, it may be desired to pick up sound originating some distance from the microphone while excluding nearby noises. In audience participation shows on television also, a highly-directional microphone can be valuable to pick up the speech of a person in the audience without the need for a "roving" microphone and its trailing cable.

To obtain the required directional characteristics it is necessary to employ microphones in which the directivity is obtained by sampling the sound at a number of points separated by a distance large compared with the wavelength of the sound. This class of microphone includes those in which some form of reflector is used to collect the sound and those in which the sound enters through tubes. An early form of tube microphone was the Western Electric "Machine Gun", which consisted of a bundle of tubes of graded length attached to the front of a pressure microphone. The principle of operation of this type of microphone is analogous to that of the Beverage aerial.

The Sennheiser type MD 82 and Electrovoice type 642 microphones operate on the same principle as the "Machine Gun" microphone but the numerous tubes are replaced by a single tube receiving sound through a number of openings along its length, acoustic absorbent material being introduced to reduce the effects of standing waves. The directivity pattern of the type MD 82 microphone is determined only by the length of the tube in relation to the wavelength of the sound; the type 642 microphone on the other hand relies on the tube only at frequencies above 500 c/s and operates as a conventional cardioid at lower frequencies.

2. DESCRIPTION OF MICROPHONES

The appearance and dimensions of the microphones are shown in Figs. 1 and 2.

In the type MD 82 microphone the tube is 1 m long, sound being admitted through a slot which runs practically the full length. To compensate for high-frequency losses in the microphone system, a series of small resonators is distributed along the slot. These resonators, which are formed by a row of external fins about 3 mm apart, are protected by a wire gauze casing. The microphone is attached to the stand stirrup by a cross-piece rigidly attached to the tube. A pin through the cross-piece permits tilting of the microphone; accidental tilting is prevented by locking screws on either side of the stirrup. The output impedance of the type MD 82 is 200 ohms nominal.

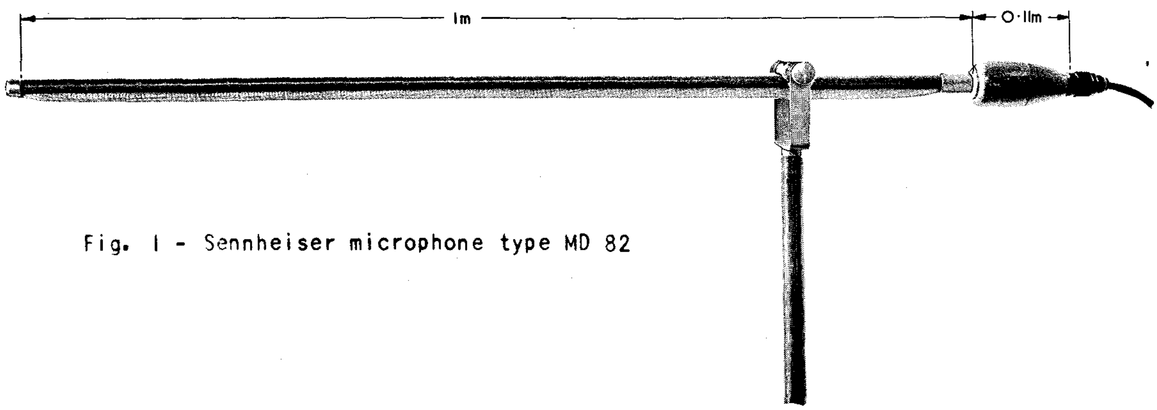


Fig. 1 - Sennheiser microphone type MD 82

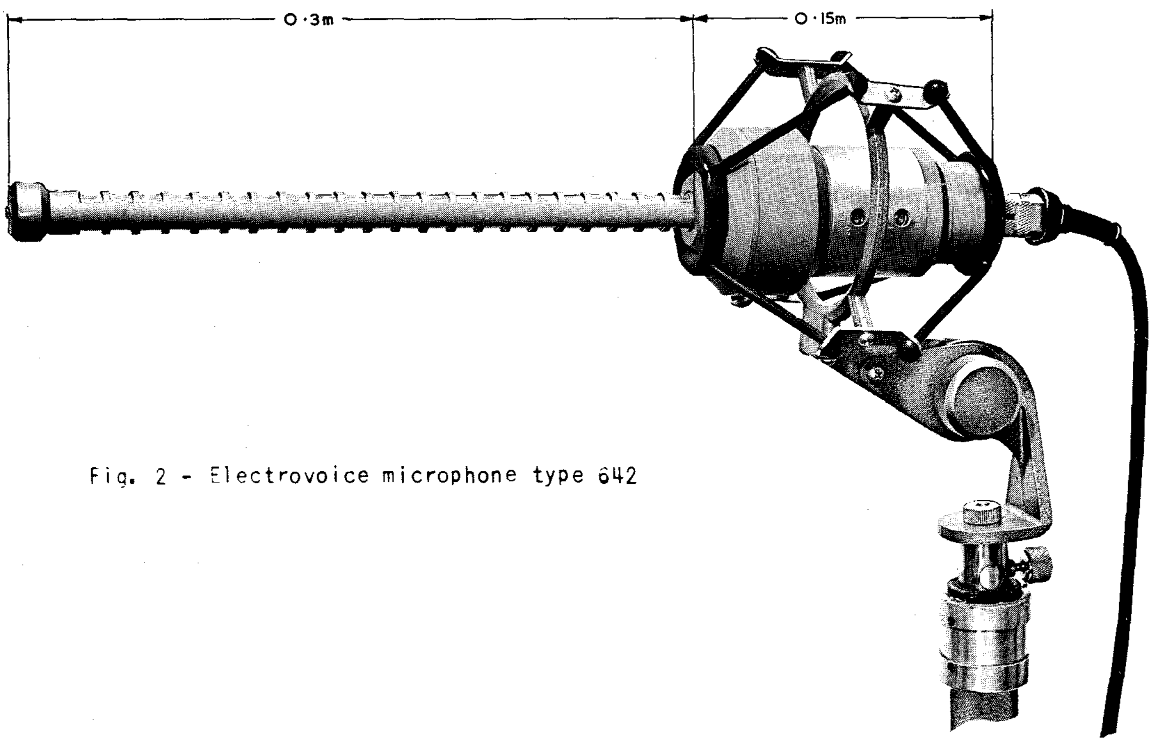


Fig. 2 - Electrovoice microphone type 642

The tube of the type 642 microphone is 30 cm long. Sound enters the tube through two rows of apertures arranged on diametrically opposite sides of the tube and provided with a protective layer of perforated metal. Two alternative accessories are available for mounting the microphone, the "Model 356 shock mount" (supplied with the specimen tested and shown in Fig. 2) and the "Model 322 stand clamp".

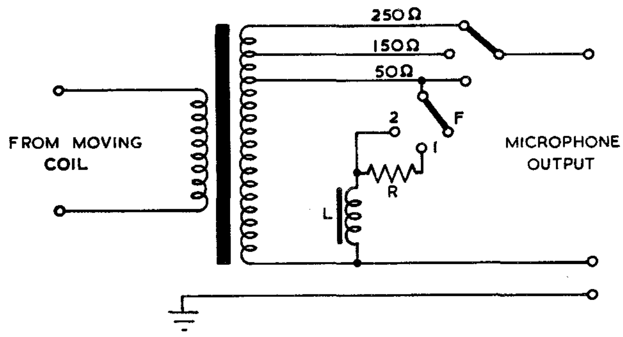


Fig. 3 - Output circuit of microphone type 642

Fig. 3 shows the output circuit of the type 642 microphone. The output impedance is either 50 ohms, 150 ohms or 250 ohms nominal, selected by means of a screwdriver operated switch. A second, similar, three-position switch controls a bass cut circuit. In position "F" of this switch no bass cut is introduced; position "1" introduces a step circuit, position "2" an inductive bass cut.

The weights of the type MD 82 and type 642 microphones are the same, 1·5 kg.

The price of the Electrovoice type 642, including shock mount model 356, was £75 in 1961.

3. METHOD OF MEASUREMENT

The frequency characteristics of the microphones at frequencies above 200 c/s were measured in a "dead" room with the mid-point of the tube in each case 2·6 m from the sound source. The corresponding measurements at frequencies below 200 c/s were carried out in a travelling wave duct. In both the dead room and duct measurements a calibrated pressure microphone was used as a standard.

The accuracy of comparison with the standard microphone is within ± 0·5 dB and the calibration of the standard itself is known to the same degree of accuracy.

As the width of the travelling wave duct did not permit measurements to be made at angles of incidence greater than 30°, it was decided to restrict frequency response measurements, both in the dead room and the duct, to 0°, 10°, 20° and 30° and to supplement these results by measurements of the directivity pattern carried out with half-octave bands of noise. The directivity pattern measurements for frequencies above 400 c/s were made in the dead room and those for lower frequencies out-of-doors.

4. FREQUENCY CHARACTERISTICS

4.1 Sennheiser Type MD 82

Fig. 4 shows the open-circuit axial response curves for two specimens of the type MD 82. The two curves are within about ± 2·5 dB of each other.

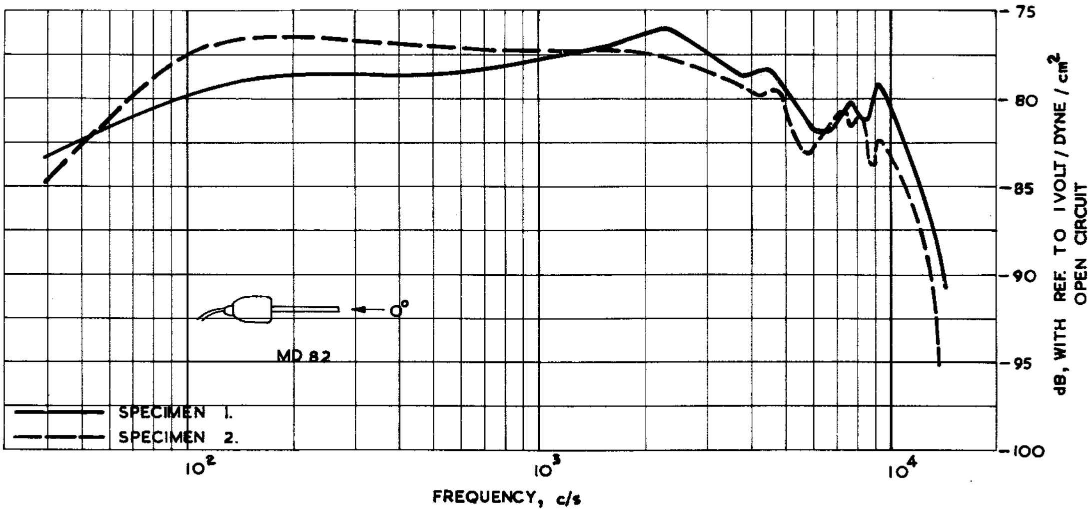


Fig. 4 - Type MD 82 microphone. Open-circuit axial frequency characteristics of two specimens

The response curves of specimen 1 for sound incident at 0°, 10°, 20° and 30° when operating with a 300-ohm load are given in Fig. 5. The effect on the axial response of operation into this load is a reduction of about 2·5 dB in the 2·3 kc/s region. It can be seen that the loss of high frequencies, at even small angles of incidence, is very pronounced.

4.2 Electrovoice Type 642

Fig. 6 shows the open-circuit axial response of the type 642 microphone measured on the 150-ohm tap and with the bass cut switch set to "F". The raggedness of the curve at frequencies above about 2 kc/s is due to discontinuities in the tube.

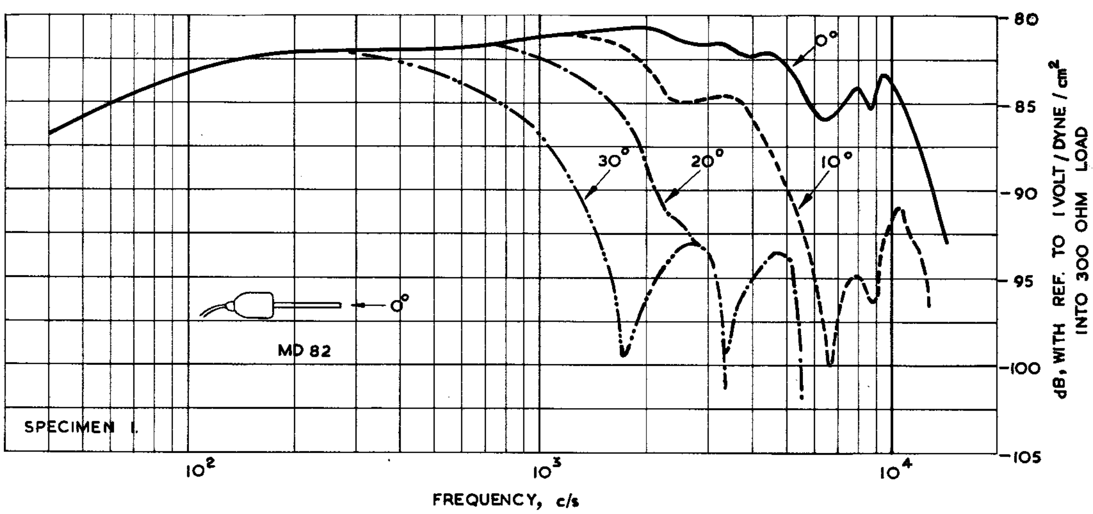


Fig. 5 - Type MD 82 microphone. Frequency characteristics, with 300-ohm load, for sound incident at various angles

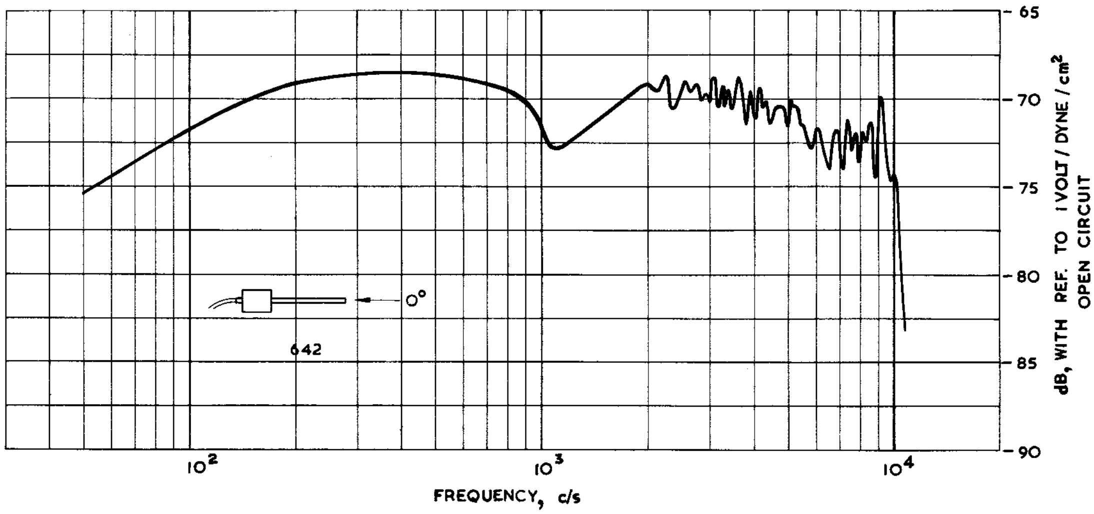


Fig. 6 - Type 642 microphone. Open-circuit axial frequency characteristics
150-ohm nominal impedance. Bass cut switch in position "F"

However, these irregularities in response never exceed ± 2 dB and, as the spacing between successive maxima is small, the effect on quality is unlikely to be serious.

The open-circuit frequency response characteristics of the type 642 for sound incident on the axis and with the bass cut selection switch in the positions "F", "1" and "2" in turn are shown in Fig. 7. Fig. 8 shows the axial response curves of the microphone again switched to the three bass cut positions "F", "1"

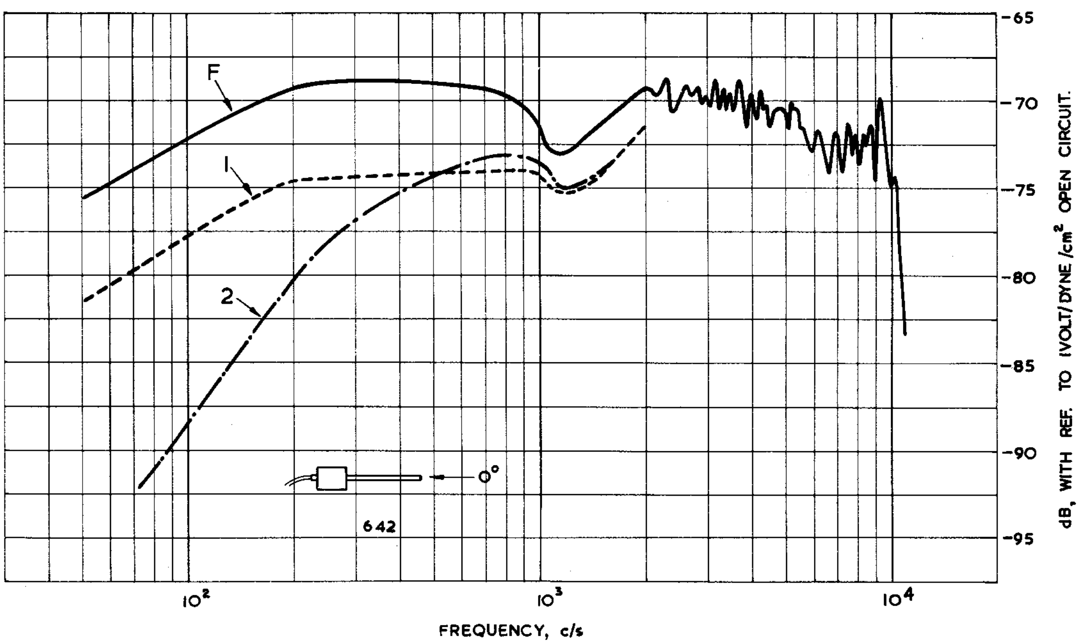


Fig. 7 - Type 642 microphone. Open-circuit axial frequency characteristics
150-ohm nominal impedance. Bass cut switch set to "F", "1" and "2" in turn

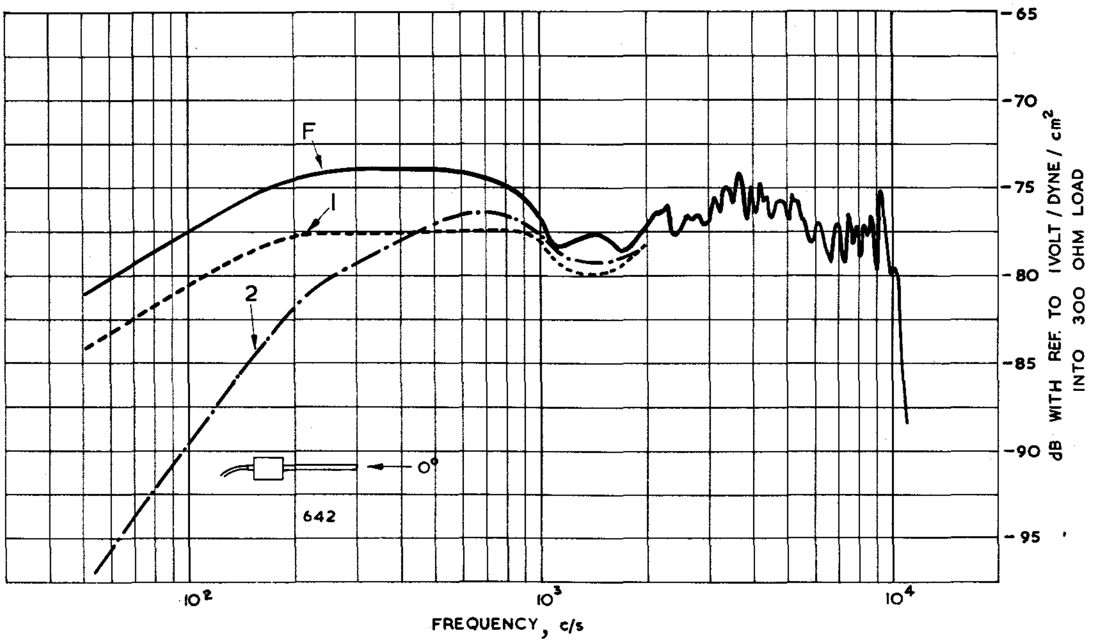


Fig. 8 - Type 642 microphone. Axial frequency characteristics, with 300-ohm load. 150-ohm nominal impedance. Bass cut switch set to "F", "1" and "2" in turn

and "2", but operating this time with a 300-ohm load. It will be noted that when the microphone is loaded with 300 ohms (Fig. 8) the effects of the shunt bass cut circuit are appreciably less than when the microphone is operated open-circuit (Fig. 7).

Fig. 9 gives the response curves for sound incident at 0°, 10°, 20° and 30° to the axis with the bass cut selection switch in position "F" and with the microphone

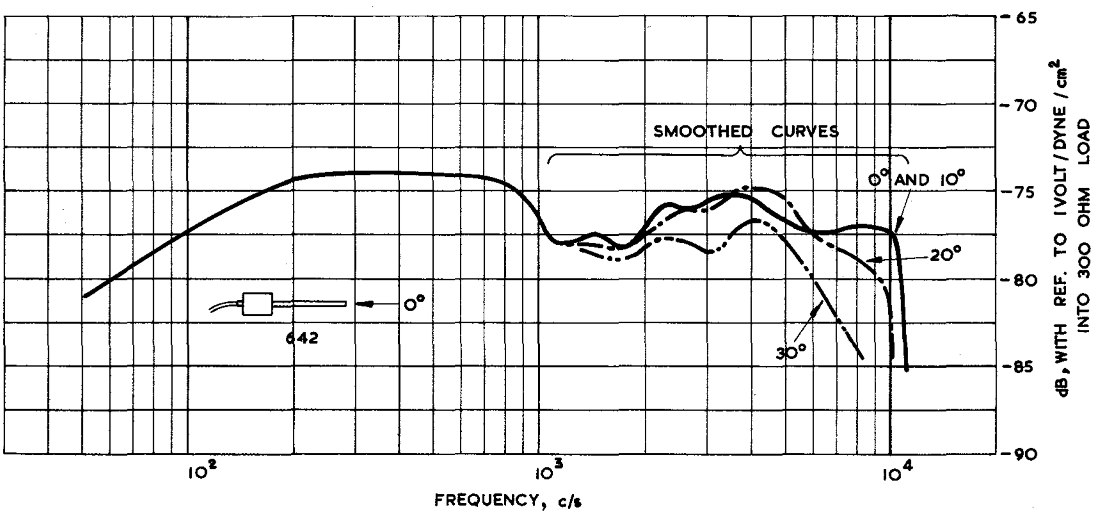


Fig. 9 - Type 642 microphone. Frequency characteristics, with 300-ohm load, for sound incident at various angles. 150-ohm nominal impedance. Bass cut switch set to "F"

output terminated with a 300-ohm resistor. To facilitate comparison between the three curves the smaller irregularities in response have been smoothed.

5. IMPEDANCES

The modulus of impedance of the type MD 82 microphone is shown in Fig. 10a, while Fig. 10b gives the correction to be applied to the open-circuit response curve when the microphone is operated into a 300-ohm load. The impedance at 1 kc/s is 160 ohms. The variation in impedance with frequency will affect the response of other microphones used in a low-level mixing circuit, but only to the extent of 1 dB at 2·3 kc/s in the output of a single parallel-connected 300-ohm microphone operating into a common 300-ohm load.

Fig. 11a shows the modulus of impedance of the type 642 microphone at the 150-ohm setting of the impedance switch and with the bass cut switch set to "F", "1" and "2" in turn; the effect of operating the microphone into a 300-ohm load is given in Fig. 11b. Without the bass cut the impedance at 1 kc/s is 240 ohms, i.e., 60% higher than the nominal 150 ohms. In the specimen tested the impedance on all tap positions is higher than the nominal by the same factor and for this reason the tests were carried out on the 150-ohm tap; it is recommended that, for best match, the microphone should be operated in this condition when working into a 300-ohm load.

The variation of impedance with frequency is sufficient to affect the response of any microphones which may be connected in parallel with it in a low-level mixing circuit. With no internal bass cut (i.e., switch position "F") a 2 dB rise will be caused at about 1·8 kc/s in the output of a 300-ohm microphone operating into a common 300-ohm load. The effect is, however, much more severe at the bass end with the bass cut switch set to position "2"; here a bass cut of some 12 dB at 50 c/s would be imposed on the parallel-connected microphone operating as described above.

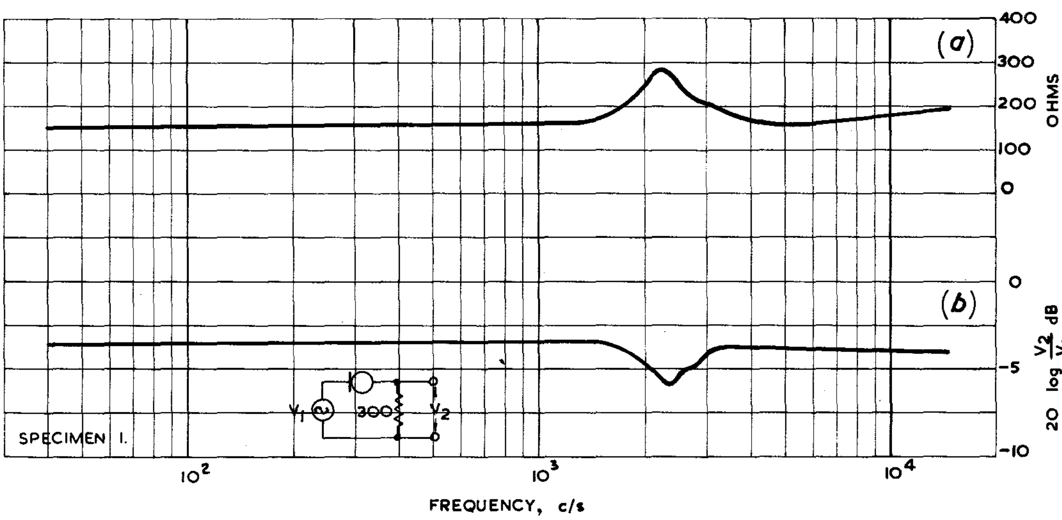


Fig. 10 - Type MD 82 microphone

(a) Variation of output impedance with frequency

(b) Relationship between open-circuit voltage and voltage developed across 300-ohm load

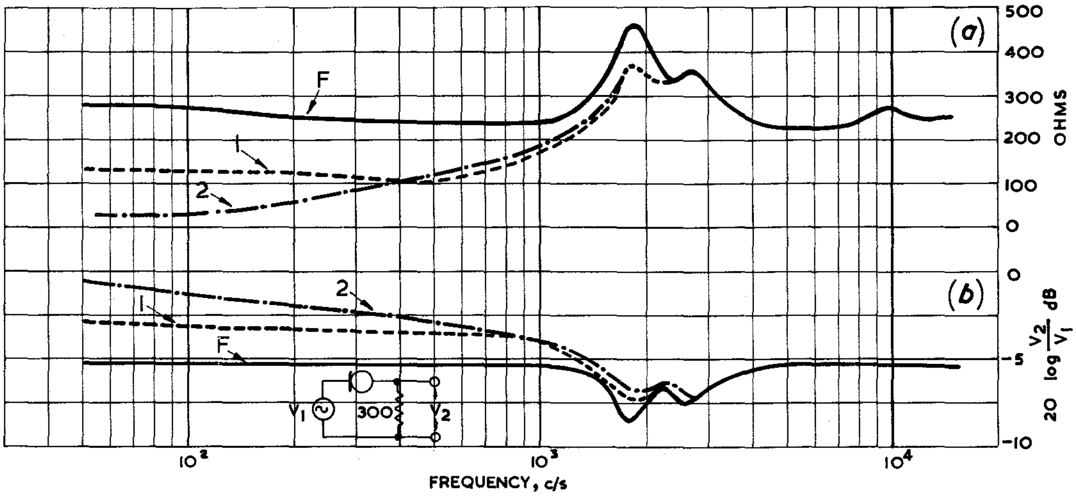


Fig. 11 - Type 642 microphone

(*a*) Variation of nominal 150-ohm output impedance with frequency bass cut switch set to "F", "1" and "2" in turn

(*b*) Relationship between open-circuit voltage and voltage developed across 300-ohm load. 150-ohm nominal impedance. Bass cut switch set to "F", "1" and "2" in turn

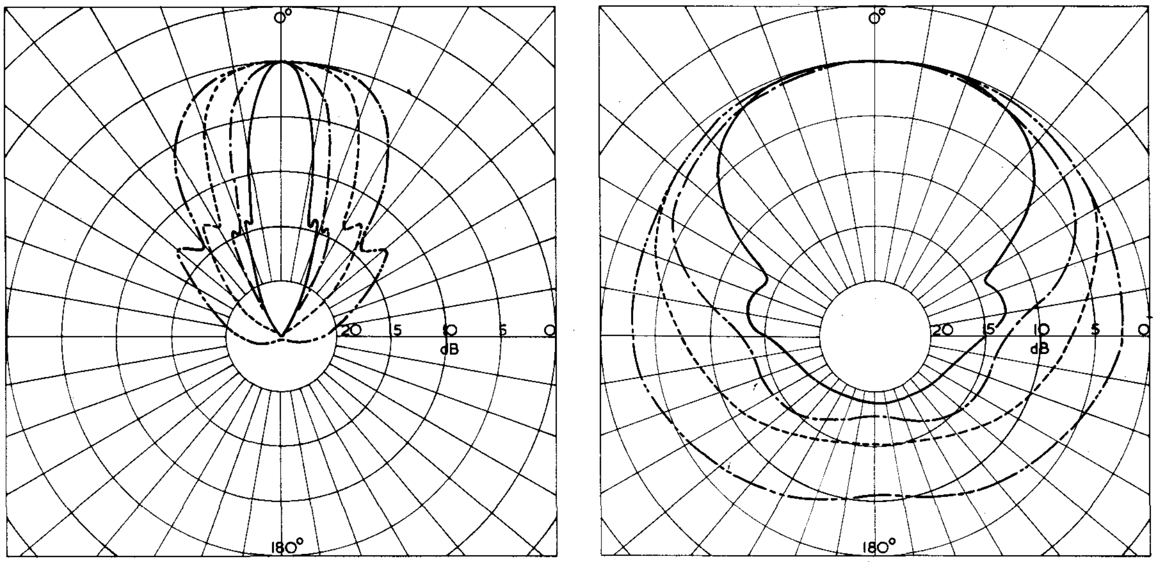
6. DIRECTIVITY PATTERNS

Polar response curves for the type MD 82 microphone, measured with half-octave bands of noise, are given in Figs. 12a and 12b while corresponding curves for the type 642 are shown in Figs. 13a and 13b; it will be noted that the latter curves exhibit slight asymmetry at the higher frequencies.

For quick reference, Table 1 gives the angular width of the polar lobe measured between the points at which the response is 6 dB below its maximum value.

TABLE I

Mid-frequency of half-octave band of noise	Width of beam between -6 dB points	
	Type MD 82	Type 642
9·0 kc/s	18°	60°
4·5 kc/s	28°	88°
2·25 kc/s	42°	88°
1·125 kc/s	60°	130°
560 c/s	96°	166°
280 c/s	140°	168°
140 c/s	166°	168°
70 c/s	246°	174°



(a) (b)

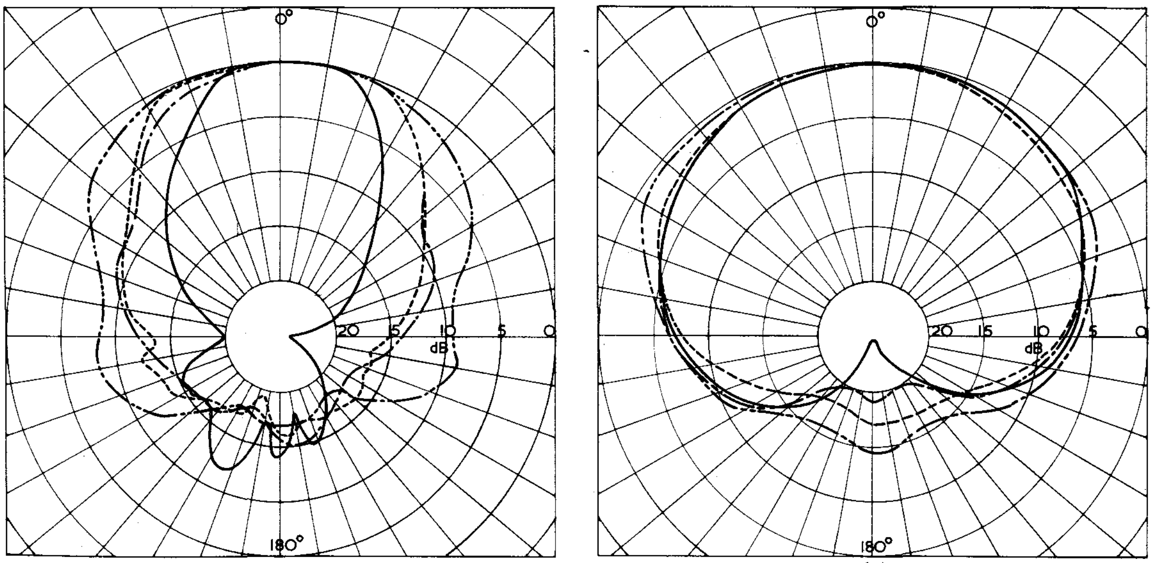
Fig. 12 - Type MD 82 microphone

(a) Directivity patterns measured with half-octave bands of noise centred on frequencies:

————	9·0 kc/s
—·—·—	4·5 kc/s
- - - - -	2·25 kc/s
-··—··-	1·125 kc/s

(b) Directivity patterns measured with half-octave bands of noise centred on frequencies:

————	560 c/s
—·—·—	280 c/s
- - - - -	140 c/s
-··—··-	70 c/s



(a) (b)

Fig. 13 - Type 642 microphone

(a) Directivity patterns measured with half-octave bands of noise centred on frequencies:

————	9·0 kc/s
—·—·—	4·5 kc/s
- - - - -	2·25 kc/s
-··—··-	1·125 kc/s

(b) Directivity patterns measured with half-octave bands of noise centred on frequencies:

————	560 c/s
—·—·—	280 c/s
- - - - -	140 c/s
-··—··-	70 c/s

7. SENSITIVITIES

The open-circuit sensitivity of the type MD 82 microphone in the mid-band region is approximately −78 dB with reference to 1 volt/dyne/cm^2. The corresponding figure for the type 642 microphone is approximately −70 dB with reference to 1 volt/dyne/cm^2.

The two microphones, being of different impedance, are not affected by the same amount when loaded by the same value of resistance. If each microphone is operated into a 300-ohm load the type 642 gives about 6 dB more output in the mid-band region.

8. NOISE

8.1 General

In the absence of interference the noise output of the type MD 82 and type 642 microphones is that due to the resistive components of the impedances and may be calculated accordingly.

In the case of the type MD 82 microphone the sound level in the mid-band region which would produce a microphone output equal to that due to the weighted noise is approximately +22 dB with reference to 0·0002 dyne/cm^2.

The corresponding figure for the type 642 is +16 dB with reference to 0·0002 dyne/cm^2.

8.2 Interference from Magnetic Fields

The open-circuit output of each microphone due to a uniform magnetic field was measured at 50 c/s, 1000 c/s and 10 kc/s, the orientation being chosen at each measurement to give the greatest output. Table 2 lists the mid-band sound levels required to give the same output from the microphones as that produced by a magnetic field of 1 milligauss.

TABLE 2

Frequency	Sound level in mid-band region to give open-circuit output equal to that due to a magnetic field of 1 milligauss 0 dB = 2×10^{-4} dyne/cm^2	
	Electrovoice type 642 dB	Sennheiser type MF 82 dB
50 c/s	+24	+39
1 kc/s	+19	+35
10 kc/s	+23	+25

Note: The measurements in the case of the Electrovoice type 642 microphone were made with the bass cut switch in position "F".

9. CONCLUSIONS

The axial frequency response curves of both microphones show some defects but the performance is in each case adequate for many purposes.

The directional characteristics of the two microphones differ considerably and it would not be safe to regard either as a replacement for the other in all applications. The acceptance angle of the type MD 82 is narrower than that of the type 642 microphone at all frequencies above about 140 c/s and the type MD 82 is therefore the less susceptible of the two to interference from extraneous noises in the studio. The type MD 82, however, becomes excessively directional at high frequencies; it has therefore to be accurately aimed and can cover only a small stage width without degradation of quality. The polar characteristics of the type 642 microphone, while wider than those of the type MD 82 are, however, appreciably narrower over a large part of the frequency range than those of the normal types of studio microphone. In comparison with the type MD 82 the type 642 has the advantage of being small enough to permit boom operation. The polar diagrams of both microphones become narrower with increasing frequency, the range of variation being much greater in the case of the type MD 82. The application of both microphones may therefore be restricted – at least for indoor operation – to cases where electrical bass cut can be used to avoid excessive reverberation.

The signal-to-noise ratio of the type MD 82 microphone is no greater than average for studio microphones intended for normal working distances; thus distant working can be achieved only by accepting a degradation of overall signal-to-noise ratio. The type 642 is somewhat better than usual in this respect and an acceptable signal-to-noise ratio can be achieved at a greater than normal working distance.

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